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A TEA PLANT IN BLOOM.

U. S. DEPARTMENT OF AGRICULTURE.
BUREAU OF PLANT INDUSTRY—BULLETIN NO. 234.
B. T. GALLOWAY, *Chief of Bureau.*

THE CULTIVATION AND MANUFACTURE OF TEA IN THE UNITED STATES.

BY

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Scientific Assistant, Drug-Plant, Poisonous-Plant, Physiological, and Fermentation Investigations.

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LETTER OF TRANSMITTAL.

U. S. Department of Agriculture,
Bureau of Plant Industry,
Office of the Chief,
Washington, D. C., September 26, 1911.

Sir: I have the honor to transmit herewith and to recommend for publication as Bulletin No. 234 of the series of this Bureau a manuscript by Mr. George F. Mitchell, Scientific Assistant, entitled "The Cultivation and Manufacture of Tea in the United States," submitted by Dr. R. H. True, Physiologist in Charge of the Office of Drug-Plant, Poisonous-Plant, Physiological, and Fermentation Investigations.

This bulletin brings together the most important results of the experiments in commercial tea culture begun by Dr. Charles U. Shepard, and later continued by him in connection with this Bureau. The work has been carried on at Summerville, S. C., and has been participated in on the part of the Department by Mr. J. H. Kinsler, Scientific Assistant, and later for a long period by Mr. Mitchell, the author of this bulletin. It is believed that this experiment has gone far to demonstrate the practicability of growing tea commercially in suitable parts of this country, and it should call attention to an important agricultural opportunity not yet accepted.

Respectfully,

B. T. Galloway,
Chief of Bureau.

Hon. James Wilson,
Secretary of Agriculture.

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THE CULTIVATION AND MANUFACTURE OF TEA IN THE UNITED STATES.

HISTORY OF TEA GROWING IN AMERICA.

The tea plant seems to have been first successfully grown in this country by the French botanist Michaux, who planted tea about the year 1800 at Middleton Barony on the Ashley River, some 15 miles from Charleston, S. C. One of the supposed original plants, probably grown for their decorative value, survived and when seen by Dr. Charles U. Shepard about 25 years ago had reached a height of nearly 15 feet. The first attempt to introduce tea culture into America seems to have been made by Dr. Junius Smith, who in 1848 turned his attention to tea growing on his estate near Greenville, S. C., basing his effort on imported seeds and plants. In articles in the American Agriculturist of 1851 he stated that his plants had done well, having withstood a snowstorm of from 8 to 9 inches. He added: "I can not help thinking that we have now demonstrated the adaptation of the tea plant to the soil and climate of this country, and succeeded in the permanent establishment of tea within our own borders." Upon the death of Dr. Smith the tea plants left without care soon disappeared.

The interest of the National Government seems to have been first aroused in 1858, when, through the action of the Commissioner of Patents, Mr. Robert Fortune was sent to China to obtain seed for planting in this country. Plants were widely distributed in the Southern and Gulf States, and reports that they had been successfully cultivated were received from many persons. In a great many cases the growers made tea by domestic processes for home use, but no records of sales have been found. In 1880 the interest of the National Government in tea growing again revived under Commissioner of Agriculture William G. Le Duc, who, seeing that the introduction of the plant alone was not sufficient to lead to the development of an industry, secured the services of Mr. John Jackson, a tea planter of 14 years' experience in India, who was instructed to carry out the experiments necessary to test the feasibility of growing and

manufacturing tea in this country. An area of 200 acres of land near Summerville, S. C., was leased for 20 years from Mr. Henry A. Middleton, and tea seed was imported from Japan, China, and India, a small stock being also obtained from the few surviving plants previously distributed by the Patent Office. From the small tea fields resulting from these plantings, Mr. Jackson made small quantities of excellent teas which received the hearty commendation of prominent tea tasters to whom they were submitted. Before this work could develop materially Commissioner Le Duc was succeeded by Commissioner George B. Loring, who because of the illness of the tea expert, Mr. Jackson, and for other reasons caused the experiment to be abandoned.

About 1890 Dr. Shepard, believing that the experimental attempts previously made did not conclusively demonstrate that tea growing in the United States was out of the question, began the growing of tea, at first on a small scale. The reasons leading him to undertake seriously to do what had hitherto failed were several.

(1) The successful growth throughout the South Atlantic and Gulf States of a large number of oriental trees and shrubs demanding the same conditions as the tea plant seemed to indicate that the climate and soil were favorable.

(2) The abundance of suitable labor at a moderate cost furnished by colored women and children seemed to promise well, and the desirability of finding light labor during the summer season for these classes of the population seemed great.

(3) Thousands of acres of idle land, well suited to tea growing after proper preparation, could be made productive.

(4) Upwards of $16,000,000 sent abroad annually to purchase tea could be expended in paying for a home product.

(5) The American people could be supplied with a clean, pure article undeteriorated by a long ocean voyage.

Dr. Shepard believed that the previous attempts by the Government had failed partly because of administrative reasons, partly through the illness and death of the tea expert in charge and partly through a lack of persistence necessary to carry the work through to success. Pinehurst was selected as the location for his experiment because it was near the old experimental garden chosen by Mr. Jackson and because the somewhat rolling land contained a variety of soils. Furthermore, Summerville, being a popular winter resort for tourists, offered a special market for the product, and through the interest arising from the inspection of the tea gardens and factory and from "tea talks" given from time to time by the proprietor, this location seemed to present special opportunities for carrying on an educational campaign in favor of American tea.

DESCRIPTION OF THE TEA PLANT.

The tea plant, *Thea sinensis* L. (Pl. I), belongs to the family Theaceæ, a group especially well developed in tropical and subtropical regions and which includes the ornamental camellias. Although the home of the wild tea plant is not definitely established it appears that it is indigenous in Assam, where it occurs as a good-sized tree, reaching at times a height of 30 to 90 feet. It is supposed by Kiefer [1] to have been distributed from this general region to those parts of the world in which it is now known. For some time there was some doubt with regard to the number of species, but it seems to be generally accepted that the single species of Linnæus is alone valid, the supposed species of later botanists being no more than varieties. The difference in stature seen between the tea plant in cultivation and in these tropical jungles seems not to represent two botanical differences but to have arisen through adaptation and selection. In order to bring the plant within the range of commercial utilization its height is restricted by the method of growth and pruning to 2 to 6 feet.

The lanceolate to oblong-lanceolate, rather dully evergreen, serrate leaves vary in length from 1½ to 10 inches and in width from one-half to 4 inches. When mature they are rather thick, smooth and leathery, borne on a short petiole, and arranged alternately on the stem. The fragrant flowers, occurring singly or in groups of two or three in the axils of the leaves, consist of five conspicuous white petals which surround the showy group of many yellow stamens. The fruit consists of from one to three hard-shelled dark-brown nuts, somewhat resembling hazelnuts in size and shape.

In its ability to adapt itself to a wide range of conditions the tea plant is exceeded only by wheat, thriving from 30° north latitude in Japan to 31° south latitude in Natal, South Africa, and in Australia, and from 35° north latitude in the Western Hemisphere south into Brazil. Although this species as a whole has such a wide geographical range, not all varieties thrive equally well in any one locality. The Ceylon types from low altitudes do not thrive at high elevations on this island, nor will the broad-leaved Ceylon and Assam varieties flourish when transplanted to localities where the precipitation is small, where lower temperatures prevail, or where high winds are frequent. On the other hand, they do admirably where the rainfall is heavy and tropical temperatures prevail.

When the evaporation from the broad leaves tends to exceed the supply of moisture furnished by the roots, the plants either succumb or undergo a reduction of the leaf surface until they resemble the narrow-leaved stunted types.

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[1] Kiefer, A. Die Theeindustrie Indiens und Ceylons. Abhandlungen der K. K. Geographischen Gesellschaft in Wien, vol. 4, no. 3, 1902, pp. 1-66.

Other varietal differences appear in the chemical characteristics of the leaves, as is seen by the fact that certain varieties, such as the broader-leaved types represented by the Assam hybrid and Ceylon teas, are better adapted for making black tea, while the narrow-leaved Chinese and Japanese types are more suitable for the manufacture of green tea. These differences are due, as is more fully explained later, to the relative amounts of certain oxidizing ferments and oxidizable substances present in the leaves.

COMMERCE AND STATISTICS.

Tea is a staple crop of four countries, namely, India, Ceylon, China, and Japan, and at present extends the promise of playing an important rôle in the industries of the Southern States. The world's annual consumption, exclusive of the very large local use in China (the extent of which can not be determined), amounts to more than 700 million pounds, over 250 million pounds being produced in India, about 200 million in Ceylon, 150 million in China, 60 million in Japan, 20 million in Formosa, and 17 million in Java. Tea is raised also in Natal, in the Russian Caucasus, and to some extent in Jamaica. The people of the United States, although considered a coffee-drinking nation, consume annually upward of 100 million pounds of tea, for which $16,000,000 or more are paid.

Table I, presenting the imports of tea for every fifth year from 1853 to 1908, inclusive, shows a general increase in the quantity of tea imported, but the consumption per capita and the price per pound, although very variable, have on the whole decreased.

TABLE I.—*Imports of tea into the United States every fifth year from 1853 to 1908, inclusive.*

Years.	Quantity imported.	Import value.	Average import price per pound.	Consumption per capita.
	Pounds.		*Cents.*	*Pounds.*
1853	22,721,745	$8,224,853	36.4	0.75
1858	32,995,021	7,261,815	20.4	.97
1863	29,761,037	8,013,772	25.8	.80
1868	37,843,612	11,111,560	29.2	.96
1873	64,815,136	24,466,170	37.7	1.53
1878	65,366,704	15,660,168	23.6	1.33
1883	73,479,164	17,302,849	23.5	1.30
1888	84,627,870	13,360,685	15.8	1.40
1893	89,061,287	13,857,482	16.0	1.33
1898	71,957,715	10,054,283	13.9	.94
1903	108,574,905	15,659,229	14.4	1.30
1908	94,149,564	16,309,870	17.3	1.07

Of the 94,149,564 pounds imported in 1908, about 27 million came from China and 47 million from Japan, the other 20 million coming from India and Ceylon. Although the two latter countries have made every effort to gain prestige in the tea trade and are gaining every day, the Chinese and Japanese teas are still in the lead, owing perhaps to the demand for green and oolong teas. This demand so far

has not been successfully met by Ceylon and India, but black teas are constantly becoming more popular in the United States and in time may supplant the green teas, as has been the case in Great Britain.

It is possible that by establishing a tea industry at home the consumption of tea in the United States can be greatly increased, as it has been in Great Britain since tea became a staple crop of her colonies in the East Indies.

ESTABLISHING A TEA PLANTATION.

Selection of sites.—The land for a tea plantation should be comparatively flat and uniform over large areas in order to admit of the use of farm machinery and to save the time lost in moving from one small field to another when cultivating and gathering the crop. Cleared land should be selected in order to avoid the expense of removing forest and undergrowth, which at the present price of labor would be very great. The site should be convenient to railroad or river transportation, but away from mining, manufacturing, or truck-growing centers, where labor usually commands a price too high to pay for ordinary farm help. As all the members of a family may be employed in the work of a tea plantation there should be many separate houses provided for laborers in order to guarantee an abundance of labor at all times. A sufficient and convenient supply of fuel for future factory requirements must also be provided.

Other things being equal, it is better to avoid hillsides for tea gardens, since they are difficult to cultivate and are subject to denudation by heavy rains. The familiar representations of Chinese tea gardens as seen on our grandmothers' blue china relate rather to the cultivation, largely by priests, of very high-grade tea on precipitous mountain slopes where the declivity is so great that in some instances it is necessary to use chains in order to prevent the laborers from falling into the intervening valleys. Again, in the tea gardens on the mountain slopes of the Himalayas and the more elevated districts of Ceylon the tea has to be planted on terraces which are costly to construct and which can not be cultivated with other than manual tools, thus increasing the expense of production. Moreover, such situations are liable to disastrous landslides.

Climate.—The climate of the Southern and Gulf States is in general fairly suited to the cultivation of the tea plant. Although the rainfall is much less than in most of the tea-producing countries, the average annual temperature is lower; hence, less evaporation and therefore less rainfall is needed.

The tea plants, except those from tropical climates, can be safely cultivated where the temperature seldom falls below 20° F. (beyond that degree of cold lies considerable danger), and where the annual

precipitation amounts to 50 inches or more. At least 30 inches should fall during the cropping season. For a successful yield the mean temperature for the plucking season should not fall below 70° F. If there is plenty of rain, high temperatures increase the rapidity of growth. Frequent winds, especially if dry and hot, are very detrimental to tea culture, as also are long periods of drought. Cool nights in summer interfere with rapid and luxuriant growth and materially reduce the yield. The rainfall should be evenly distributed during the plucking season, downpours doing relatively little good to the plants and generally proving very destructive in consequence of the denudation of the soil.

An endeavor has been made to supplement the rather scanty rainfall at Pinehurst during the cropping season by a system of irrigation, both superficial and at a shallow depth from the surface, so as to offset the generally larger water supply of the Oriental tea gardens; but the result thus far has not proved successful. The failure probably arises from the inadequate supply of water at the critical periods of drought. If the tea gardens were placed on some of the abandoned rice fields of the South Atlantic coast the old sources of artificial irrigation might be advantageously utilized to remedy any deficiency in this respect.

Soil.—For its successful growth the tea plant requires a deep, fertile, well-drained, friable, and easily penetrable loam containing a large amount of well-decomposed organic matter. The soil should be thoroughly drained, naturally or artificially, to a depth of at least 36 inches. Very tenacious undrained soils or very sandy soils that lack water-retaining properties are not adapted to the growth of tea; neither will the plant tolerate stagnant water in the subsoil. The best tea soils contain very little lime, and when this constituent exists in excess it seems to be deleterious to the growth of the plant. Although the soil must be well supplied with thoroughly decomposed organic matter, an excessive quantity causes the leaves to develop rapidly and the tea produced from them is very weak. The quality of the tea depends largely on a sufficient supply of phosphoric acid and potash.

Seed.—In establishing a tea plantation there is nothing more important than the selection of seed, especially when it must be imported. The average cost of imported tea seed exceeds $50 per 100 pounds delivered in the Southern States, and when it is considered that about only one in three shipments arrives in good germinating condition the cost of importation assumes a high figure. The seed should be packed in dry earth or charcoal, or both, in metallic or strong wooden boxes and hermetically sealed. A box of 100 pounds of tea seed contains from 30,000 to 40,000 seeds and the

germination will vary from 95 per cent to zero, according to the success of the importation.

In this country the seed is ready to be gathered in October and November. With some varieties and in some localities the seed matures earlier than in others. Seed that has dropped on the ground should be avoided as inferior. It is better to select the capsules containing the seed from strong healthy plants and spread them out in some dry building to open. As soon as possible every tea planter should establish a seed grove where the plants are rarely, if ever, pruned. Bushes can not be expected to produce both leaf and seed in quantity and quality. Hence, a garden cultivated for leaf should produce a minimum amount of seed. The best quality ("jat") generally yields the least seed. If more than one variety is planted on an estate the seed groves for the respective sorts should be well isolated in order to prevent hybridization.

Tea seed gathered from the gardens at Pinehurst costs less than $5 per 100 pounds. The expense of importation will be unnecessary as soon as tea gardens become general in this country, and those that have done best locally are now produced on the Pinehurst estate. It has been found that plants once removed from the original imported seed do as well as those grown from imported stock.

Although at Pinehurst success has usually followed the attempts to raise seed from most of the tea-producing countries, the following may be especially recommended as profitable: The "Darjeeling" from the Himalayan slopes of British East India, probably a cross between the Chinese and Assamese varieties, is well adapted for the production of both green and black tea, as are also the Ceylon varieties from very high altitudes (not less than 5,500 feet). The Chinese variety is especially adapted to the making of green tea, but gives a comparatively small yield. Excellent results have been obtained from a hybrid of the Assamese and Chinese types, locally called "Assam hybrid," but this variety does not make green tea of as fine quality as those before mentioned.

In pruning tea plants most of the embryonic seeds are removed, but with careless pruning many are apt to be left on the bushes, with the result that a large amount of the food supply of the plant is used up in maturing the seeds, as is shown by the following experiment: The field selected was pruned less severely than usual, but apparently no great excess of young seed had been left on the bushes. The plants were about 8 years old, of the Assam hybrid variety, planted on comparatively rich loam 5 feet apart, and capable of yielding about 250 pounds of dry tea to the acre. The seed was gathered in October, at which time the plants were about 4 feet tall. The previous spring each plant had received one-sixth of a pound of

a complete commercial fertilizer; that is, 300 pounds to the 1,750 plants on 1 acre. Each bush averaged 1 full pound of partially dried seed. An analysis of this seed was made by the Shepard laboratory of Charleston, S. C., with the results shown in Table II.

TABLE II.—*Analysis of tea seed left to mature after insufficient pruning of the plants, giving amount of loss of fertilizing material.*

Determinations.	With moisture present.	On a dry basis.	Loss per bush bearing 1 pound of seed.	Loss per acre on 1,750 plants.	Pounds per acre in chemical manures applied the previous spring.
	Per cent.	*Per cent.*	*Grains.*	*Pounds.*	*Pounds.*
Moisture	9.55				
Nitrogen	1.70	1.84	129	$32\frac{1}{4}$	
Equivalent of NH_3	2.06	2.27	159	$39\frac{3}{4}$	12
Phosphorus	.32	.35	$24\frac{1}{2}$	$6\frac{1}{8}$	12
Potash	.85	.94	66	$16\frac{1}{2}$	12

From this analysis it will be seen that a very considerable amount of plant food is likely to be appropriated by the seed if it is allowed to mature, because the plants are not pruned. In this experiment the pecuniary value was more than double the cost of the commercial fertilizer applied.

Nurseries.—The native seed should be planted in the autumn or early winter following the gathering; imported seed should be planted as soon as it arrives. A plat of particularly fertile, well-drained, loamy land convenient to the proposed garden should be selected. Where droughts may be anticipated, it is well to locate the nurseries near a sufficient water supply. The soil should be well tilled to a considerable depth, and all roots, stones, and other obstacles removed. The beds should be made 5 to 6 feet wide with passages left between them from 1 to 2 feet in width and 8 inches deep. These passages may serve as drains. The beds should be carefully raked over and leveled.

The seed should be placed 4 by 4 inches apart and $1\frac{1}{2}$ inches deep in little holes made with a round, pointed stick about an inch in diameter. The depth can be regulated by placing a crosspiece $1\frac{1}{2}$ inches from the pointed end. One seed should be placed in each hole and covered by simply leveling the surface. The nursery bed should be uniformly covered with some kind of straw to protect the seeds from cold and also to serve as a mulch. Pine straw (needles) has been found excellent for this purpose. As soon as the seeds begin to sprout a light frame should be set up in the passages 6 feet above the ground, supported by posts (fig. 1). The overhead frame should have spaces $1\frac{1}{2}$ inches wide so as to admit a portion of the direct rays of the sun. It can be made from any waste lumber or loosely woven wire netting and should be covered thinly with straw of some kind.

When the plants begin to come up, some of the straw should be removed from time to time and the nursery thoroughly weeded. This should be kept up until autumn, when the straw may be entirely removed and the top of the frame dispensed with. When ready to transplant, preferably after one to two years' growth in the nursery, the seedlings are removed by loosening the soil with a spade and lifting them out with only such earth as clings to the rootlets. The roots must be carefully protected from wind and cold and also from the hot sun until duly transplanted. When very young plants are to be removed, say, six months after germination, it is better to remove them with a ball of earth, which can best be done by the use of a suit-

FIG. 1.—A tea nursery.

able transplanter. If the plants are left in the nursery longer than one year they should be pruned back. This causes them to branch out instead of developing into mere switches.

Planting.—Too much care can not be exercised in the preparation of the land for tea. It should be entirely cleared of trees, stumps, roots, and grass and thoroughly drained when necessary by a system of underdrains or ditches at least 3 feet deep. Virgin land always does best when planted to some crop that requires constant cultivation the summer before setting out the tea seedlings. Indeed, previous to setting out the seedlings it is well to grow a crop of cowpeas or some other leguminous plant, which should be turned under by breaking the land flush with a three-horse plow. After the legumes decay in the soil the land should be thoroughly disked and harrowed.

In the case of hillsides it is best to construct terraces. Transplanting in this climate should be done in the late autumn.

There are two systems of planting that have given good results at Pinehurst, namely, in checks and hedges, each having its advantages under the respective conditions. When planted in checks, either rectangular or in the form of a quincunx, the latter method is to be preferred, as it affords more "plowways," thus allowing the fields to be kept clean with much less hand labor. The plants should be set out from 4 to 5 feet apart each way, which arrangement will accommodate about 2,700 and 1,750 plants to the acre, respectively, the distance varying with the habit of the variety used and with the fertility of the land. On hillsides as an aid to the prevention of washing out and on very rich lands able to stand a luxuriant growth, planting in hedges is preferable, and the plants should be placed 18 inches apart in 5-foot rows. When planted on hillsides the rows should follow the contour of the slopes, thus assisting in carrying off any excessive rainfall at a less grade and inflicting less damage than if it were permitted to descend the slopes directly. Hedges require more careful hoeing at first, but later are easier to prune and to pluck. The greater number of bushes to a given area used in hedge planting generally produces a larger quantity of tea.

Regularity must be insisted upon in planting, as it not only presents a better appearance but renders the cultivation easier. Definite lines should be laid out with the plow and checked at the proper distances. Where the furrows intersect, holes should be dug 10 inches square and at least a foot deep. If the plants are tall and slender or have much foliage it is better to prune them, leaving only a few leaves. This is best done with large hand shears before removing the plants from the nursery. The object of this pruning is to reduce the amount of evaporation from the plant proportionately to the disturbance of the roots caused by transplanting. The plants should be placed in the middle of the holes with the taproot straight down, and if the taproot is too long it may be cut off with a sharp knife on a slant. The seedling should be planted at the same depth it grew in the nursery, because if too high some of the slender roots will be exposed and if too low the bark above the surface will enter the soil, which is detrimental to the growth of the plant. About half the earth should be put back in the hole and thoroughly packed, which is best done by treading with the feet; then a quarter more should be added and this thoroughly packed. The remainder should be filled in but left loose in order to mulch the plants.

Cultivation.—Frequent and shallow cultivation that will maintain a loose mulch around the plants as well as keep them free from weeds is especially important during the spring and early summer, when

evaporation is very pronounced and the usual rainfall scant. Shallow mulching is best attained by single-horse sweeps, which can be run very near the plant. Young fields planted in hedges require weeding and hoeing about the stems two or three times during the season. Where the tea is planted in checks this is rarely necessary, as it is possible to keep the plants fairly clean by plows and cultivators. Hoeing is especially necessary when the grass starts in the rainy season. In the autumn after the plucking season is over, the soil should be turned up thoroughly to a considerable depth with single-horse turnplows so that aeration and disintegration of the soil may take place during the winter when there is very little evaporation.

When cultivating, care must be taken that the young plants are not injured by the hoes or covered up by the plows and cultivators. The young gardens require more attention than the older ones, as the bushes of the latter shade the ground and keep down weeds and grass and prevent evaporation from the soil.

A careful comparison of the labor required in the field and factory work of a given tea area in the Orient and at Pinehurst shows that in the Orient at least twice as many laborers are required as at Pinehurst, where mechanical devices in the field and factory are used. It is granted that wages are much higher in this country, even among the southern negroes, although of late years wages have materially advanced in parts of the Orient. Thus a difference in the cost of labor, which would appear to condemn the attempt to establish a tea industry here, does not exist to the extent usually believed. However, economy makes it necessary to substitute for hand labor improved and often special forms of agricultural implements.

Manures.—For the first few years after a plantation is started, manures are unnecessary in ordinarily fertile soil. When to begin the use of fertilizers and how much to apply depend entirely on the richness of the land. On very rich, easily penetrable soils the root system extends over such a large area that it is perhaps never necessary. At Pinehurst the lands are generally poor, and it has been necessary to manure most of them, but in some of the richest gardens this has not been required thus far. The richest lands in this section are low and have always been wet and consequently sour. Tea will not tolerate subsoil water or sour lands. Hence, after proper drainage, it is often desirable to apply caustic lime or, better, burnt marl, especially that containing phosphate of lime, not only as a corrective of acidity but also for its decomposing effect on the organic matter in the soil and the liberation of valuable mineral plant food otherwise unavailable. One-half ton of burnt marl, or perhaps 500 pounds of caustic lime, to the acre is sufficient under ordinary circumstances at Pinehurst.

The color of a healthy tea garden in the spring or early summer is a bright, yellowish green. Often before plucking it is decidedly golden, from the general development of pekoe tips. At the close of the cropping season and in the winter it should assume a lustrous, dark-green color. The color of the "shelter" tea (that protected from the direct sunlight during the summer) is of a decided blue tint. Whenever the leaves turn yellow, it is at once necessary to discover and remedy the cause, which is usually lack of nourishment or the presence of stagnant water about the roots.

Thus far no depredating insect, worm, or mildew has to any appreciable extent invaded the Pinehurst tea gardens. Considering how seriously they have injured the oriental estates, this is remarkable. The army worm has at times removed the grass from about the tea bushes, but has not attacked them. The mealy bug has made an occasional appearance, but has been readily extirpated by pruning and burning the attacked foliage. The red spider has given some trouble on tea plants elsewhere in the State, but not at Pinehurst. This insect yields to spraying.

A falling off in production, when it can not be attributed to one of the causes mentioned, generally indicates that enrichment of the soil in some form is needed. There is nothing better for the plant than heavy applications of barnyard manure in the furrows between the plant rows, especially if fortified with available phosphoric acid and potash. At Pinehurst most of the fields have rather poor, thin, sandy soil and are therefore deficient in all of the essential principles of plant food; consequently, most of them have had to be enriched. This has generally been effected with a fertilizer containing 4 per cent each of available (mostly soluble) phosphoric acid, potash, and ammonia, the last from dried fish scrap and dried blood. The manure should not be placed so near the plant that the minute feeding roots which take up the plant food may suffer injury from the plowing. The manures are best applied late in the winter or early in the spring and plowed under with the tea prunings. Cowpeas or some other suitable legume should be planted between the rows in the summer and plowed under late in the fall. Their function is threefold, namely, to shade the soil from the hot sun, to loosen up the earth by means of their roots, and to enrich the soil by the addition of their substance.

Pruning.—The tea plant is naturally arborescent and when uncultivated simply clothes itself with sufficient leaves to maintain its growth. This growth would be insufficient for a profitable tea estate and the bushes would attain too great a height for plucking. For these reasons the tea planter prunes his bushes, depriving them of a portion of their stems and leaves. This disturbs the natural equilibrium between root, stem, and foliage, with the result that nature

is spurred to restore the usual proportion by the luxuriant production of young leaf. It is not until the planter ceases his inroads on the gardens that the equilibrium is restored.

There are a great many systems of pruning used in India, Ceylon, and the other tea-producing countries, each claiming special advantages, but they may be simply adaptations to local conditions. The system practiced at Pinehurst is as follows: The first year after being transplanted into the field the plants are lightly "nipped" with the shears to induce them to put out lateral branches. The second year the bushes are pruned about 15 inches above the ground. Each succeeding year's pruning is about 2 inches above that of the previous year until the yield begins to diminish or until the plants become too tall for picking, when they should be heavily pruned about 14 inches above the ground. This should not be necessary until after the fifth year. Later on, if the bushes continue to fall off in their yield after being properly cultivated, manured, and plucked, they should be "collar pruned," that is, pruned to the ground. This causes them to put out an abundance of new shoots, which can be picked late in the same season. In all cases the prunings should be buried in the middle of the rows.

Pruning is not only a long and tedious operation but is attended with great expense, costing from $2 to $3 an acre. By the use of the mechanical pruner, constructed by the writer at Pinehurst, this cost is materially lowered. With this reduction in the cost of pruning, the bushes may be lightly trimmed in the early summer after the second plucking, as is done in Japan. It is hoped that this will increase the yield here as it does there, and it is the writer's opinion that with the systematic use of the mechanical pruner the tea bushes will become so regular in their growth that its use as a mechanical plucker also may become feasible.

By burying the tea prunings a quantity of plant food is returned to the soil, to say nothing of the improvement exerted by their physical effect on the land. The composition of such prunings, as determined by an analysis made in the Bureau of Chemistry, is given in Table III.

TABLE III.—*Analysis of tea prunings.*

[Made on a dry basis.]

Determinations.	Leaves.	Twigs.
	Per cent.	*Per cent.*
Nitrogen	2.77	0.95
Potash (K_2O)	1.44	.71
Phosphoric acid	.50	.25

As the result of an experiment instituted on rather luxuriant bushes, Dr. Shepard calculated that the prunings per acre contained

95 pounds of combined nitrogen, 56 pounds of potash, and 19.6 pounds of phosphoric acid. The necessity of restoring this material to the garden by plowing it in becomes evident when it is considered that its value, judged at the present cost of commercial fertilizers, is equivalent to three times that of the 600-pound application of a comparatively high-grade and complete fertilizer which was applied in the previous spring at a cost of about $7.50 per acre.

Before being covered in the trenches, the prunings between the tea rows should receive a dressing of acid phosphate and kainit or of burnt marl to hasten their decomposition. That they prove of great assistance to the plant is obvious from the large number of rootlets which within a year permeate the remains of the prunings.

At the beginning of the experiments it was thought desirable to limit the tea bushes to one stem. The pruning, therefore, conformed to that principle, and the centers of the plants were cut out, so as to admit of the free circulation of air. An unusual degree of cold, however, very shortly demonstrated that the single stem, unprotected by foliage, left the bark too much exposed to the weather, causing it to split and necessitating the cutting back of the plants to the ground. By promoting the growth of many shoots from each root the tea plant is fully protected by the enveloping foliage from all but very cold storms. When they occur, especially before the bushes have entered upon their dormant period, collar pruning becomes necessary.

It is particularly desirable to maintain a few young and straight stems as the source of the expected crop and to cut out as far as the cost of the operation will allow the "crowfeet" and other tangled masses of generally old and less valuable branches.

The whole operation of pruning implies constant supervision. As formerly practiced at Pinehurst with several sorts of shears and occasionally with saws, it is laborious and requires some knowledge and attention on the part of the pruners. The important question of when to cut low should be determined by the quality of the previously recorded crops, as well as by the condition of the garden at the time of pruning.

Plucking.—In plucking, which begins at Pinehurst about May 1 and continues into October, only the bud (pekoe tip) and the first two leaves are taken (fig. 2), the other leaves being generally too tough in structure and deficient in the valuable principles to make superior tea, although in the Orient the third, fourth, and fifth leaves are generally plucked. Plucking should be done by pinching off the stem with the thumb-nail and first finger just under the last leaf to be picked. The tea planter has to decide whether he will pluck for quality or quantity, and this must depend largely on his market.

COLORED CHILDREN PLUCKING TEA AT "PINEHURST," SUMMERVILLE, S. C.

The number of "flushes" and pluckings is influenced very largely by the methods employed. When plucking practically strips the shoots of stems and leaves, little opportunity is given for the formation of subsequent shoots. Therefore, in parts of the Orient the heavy cropping during the early summer is apt to leave the plant stripped of its tender stems and hence of the dormant buds. In those countries the number of pluckings rarely exceeds 3, whereas in India and Ceylon it frequently exceeds 20.

At Pinehurst the bushes are plucked every 7 to 15 days. The interval is determined by the development of the tender foliage, care being taken that it does not become tough before being plucked. If the leaves are plucked when too young, there is a decided loss in the tea produced; therefore, much judgment must be exercised in determining the proper time. The plucking of the pekoe bud and the first two leaves forces out the buds at the bases of the axils of the remaining leaves, and shoots, with the usual complement of leaves, develop in about three weeks. After the leaves of these shoots are plucked a third growth arises from the buds at the axils of the unplucked leaves, and, when these are taken, a fourth, and possibly a fifth, series follows in like manner. These growth periods are known as "flushes."

FIG. 2.—A tea shoot, showing the part to be plucked.

Although there are probably not more than 5 flushes, there may be 20 or more pickings, due to the fact that all the shoots in a flush do not develop at the same time; hence, pluckings are necessary at frequent intervals to keep pace with the continued development. At Pinehurst the plucking is done by colored children (Pl. II), who with proper supervision soon become expert in their task and, if available statistics are correct, equal and sometimes surpass the tea pickers of the Orient in the quality and quantity of leaf plucked. Under favorable conditions the children average each day about 40 pounds of green leaf, which equals 10 pounds of dry tea, but some have plucked as much as 75 pounds, which is equivalent to 18¾ pounds of dry tea. At present the Pinehurst gardens yield annually up to 600 pounds of finished tea per acre, depending on the variety and age of the plants, fertility of the soil, rainfall, temperature, and fineness of plucking.

If to a plucking of the pekoe tip and the two leaves immediately below, the third leaf (first souchong) be added, the weight of the crop is almost doubled, and if to the pekoe tip and three leaves the fourth leaf (second souchong) be added, the output is again almost doubled. It is highly probable that wherever tea is cultivated all the leaf comprising the different commercial grades is taken at one time by the pickers. Its separation into the trade grades that receive varying valuations is effected by screening at the close of the curing, since by common consent the finer the leaf, after the dust has been removed, the better the product. Leaves slow in developing make a better flavored product than those that grow rapidly, so that a small yield is generally compensated for by a more highly flavored tea. The cost of plucking averages about 1 cent for each pound of green leaf, making about 4 cents a pound for the dry tea. This perhaps can be materially reduced in many localities where the negro population is greater. The plucked leaves should not remain in the gardens, but should be taken to the factory at frequent intervals during the day. Constant and thorough superintendence is absolutely necessary if success in plucking is to be assured.

CURING, OR MANUFACTURE.

Since the distinction between the green and the black teas has already been briefly indicated and reasons assigned for the manufacture of the one or the other type, or both, in any given locality, a brief description of the processes for curing the different sorts may be entered upon.

BLACK TEA.

In curing black tea there are four important steps: Withering, rolling, oxidizing, and firing.

The functions of these operations may be summarized as follows:

Withering is a preparatory step to rolling, resulting in a desired loss of water and a flaccid mechanical condition of the leaf.

Rolling determines the strength of a tea and prevents in a measure its deterioration.

Oxidizing imparts to black tea its color and flavor.

Firing develops the aromatic principle in tea.

Withering.—When the "leaf" is brought into the factory, it is carefully weighed and inspected to see that the leaves are tender and fit for making tea (fig. 3). If any tough leaves or large stems are found, they must be culled out by the picker who brings them in. The leaves are then carried to the lofts, where they are spread very thinly and evenly on the withering trays and floors. It requires about 1 square yard of space for withering each pound of fresh leaf. To spread the leaves properly they are tossed up, giving the wrist an

abrupt turn as they leave the hand, which causes them to fall evenly. From 12 to 24 hours are required for withering, the time depending largely on the temperature and humidity. During the process the leaves lose about half their weight by evaporation, turn darker by partial oxidation, become soft and flaccid, and emit an agreeable and characteristic odor.

Rolling.—When withered they are ready for rolling, the process at Pinehurst being carried on entirely by machinery. In most tea countries the rolling by hand and foot has been displaced by the use

FIG. 3.—Weighing and inspecting the leaf.

of machinery, chiefly because it is cheaper, cleanlier, and more uniform in the result. At Pinehurst single rolling machines are doing the work which would otherwise require the labor of a hundred men or more (fig. 4). During the operation of rolling the cells of the leaves are broken and the juices which contain the principles necessary to good tea are spread over the surface of the rolled leaf, where they are subsequently dried on, easily accessible to the hot water used in making the infusion. The rolling reduces the exposed surface of the leaf, imparting to it the familiar twist of most commercial teas and thus assisting to preserve the aroma.

Rolling requires from 40 to 60 minutes, the last half of the time under increased pressure. After this process the "roll," as the mass of wet leaf is called, is put through the "ball breaker" (fig. 5). This apparatus consists of a revolving horizontal cylinder, covered with

wire cloth of quarter-inch mesh and equipped with arms revolving in opposite directions. These arms break up the lumps of moist matted leaf and separate the fine and well-rolled leaf from that which is coarse and incompletely rolled. The latter is rerolled under heavy pressure.

Oxidizing.—The rolled leaf is then carried to the oxidizing room and spread in a layer about 2 inches thick on clean wooden tables (fig. 6), and clean cloths moistened with water are supported over them on wire frames. The oxidizing room should be kept clean,

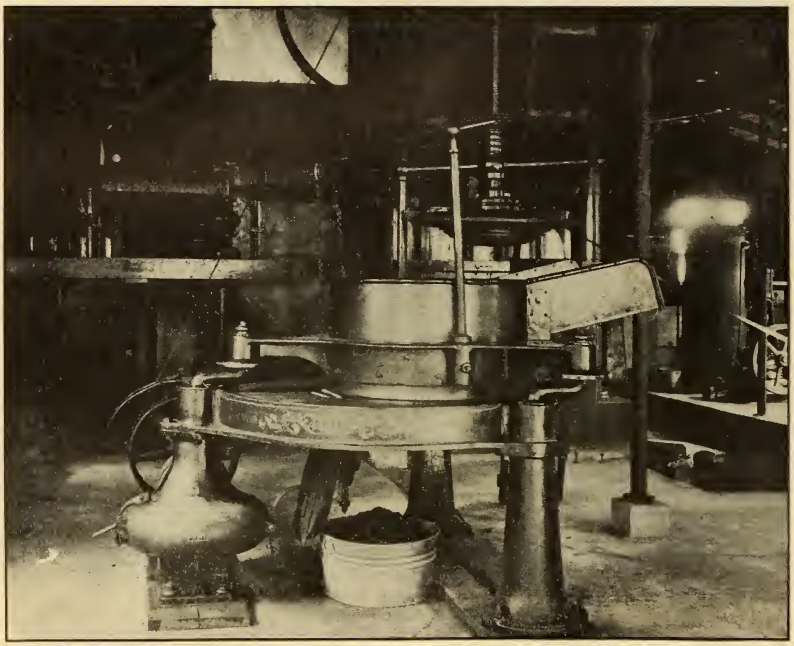


FIG. 4.—A tea-rolling machine.

damp, and as cool as possible. The best results are obtained where the temperature is regulated at 75° to 84° F. Under these conditions the leaf gradually changes from a dark-greenish to a coppery color and the leafy odor is converted into a characteristic fruity one. If the oxidation be too long protracted, the leaf assumes a dull copper-red color, and while the manufactured tea would give a deeper colored liquor it would be weak and lacking in aroma. Oxidation requires from two to six hours, the proper time to stop the operation being determined only by experience. The transformation should be by oxidation and not by fermentation, which produces acidity, the slightest trace of which is ruinous to tea.

Firing.—After the leaf is oxidized it is dried or, as it is called, "fired," which process has for its object the dissipation of the moisture from the leaf and the development of the characteristic aroma or fragrance of tea. The rolled and, in the case of black tea, the oxidized leaf contains much water, chiefly the natural juice of the leaf, but frequently in part the result of sprinkling during the preceding operations. Whatever the source of the moisture it is necessary to forestall any fermentation likely to arise from it by firing as soon as the leaf is ready for that process. This is now accomplished in most countries which produce commercial teas by the use of drying machines. This machine (fig. 7) may be briefly described as an inclosed

FIG. 5.—A ball breaker.

series of trays with movable bottoms, on which the moist tea leaves are exposed to a blast of heated air forced up through the apparatus.

As conducted at Pinehurst, the operation consists of spreading the leaf on the sliding top tray of a 42-inch drier and pushing it into the drying box, where it meets a current of heated air (230° F.), which is drawn through the apparatus by a powerful fan. After a minute or two it is dropped through the turning slats of woven-wire cloth, which constitute the floors of the trays, onto the tray immediately below. This is done three times, by which time, three or four minutes after the beginning of the firing, the greater portion of the moisture in the leaf has been dissipated. Then the top tray is loaded with another charge of wet leaf and shoved into the drying box and

the first charge dropped on the bottom tray to remain there until it feels only slightly moist to the hand. By this system the leaf with the larger content of water is introduced into the top of the drying box and the moisture borne away without being condensed on any leaf above it. The leaf here loses its soggy condition quite rapidly, a state always regarded as destructive of flavor, and very little moisture rises from it by the time another tray is introduced above it. Although only two of the five trays are in use at any time, the more rapid dissipation of the moisture by this process prevents the protraction of the total time required to finish the firing. By using the

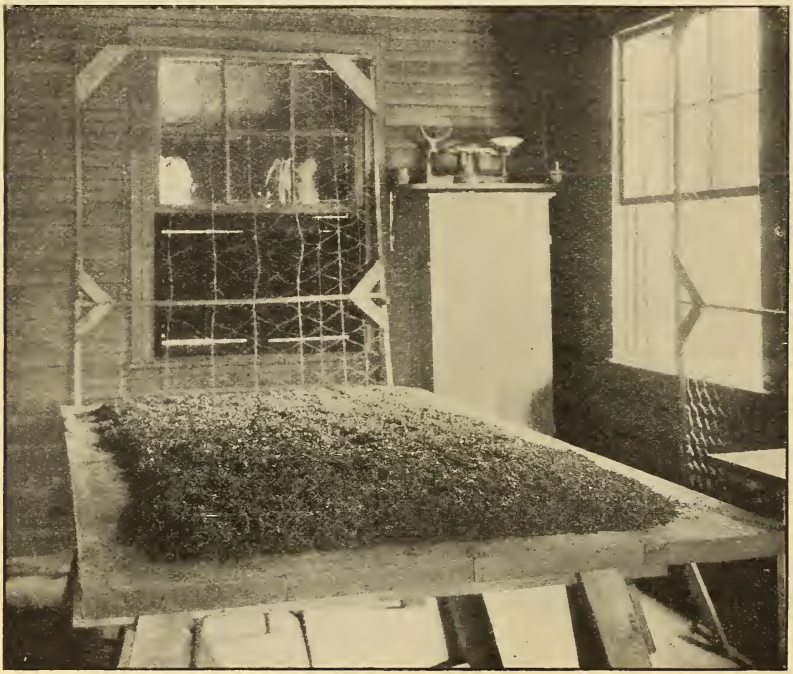


FIG. 6.—Method of oxidizing the rolled leaf. The wire screens when put into position hold up the damp cloths.

common method of employing all the trays at the same time the moisture escaping from the lower ones must necessarily suffer condensation in the upper trays, and the leaf on the upper trays will remain soggy until it has been shaken through to the lower ones. This tendency is aided by the fact that in its passage through the wet leaf the temperature of the current of air falls from an initial heat of 230° to less than 150° F. at its point of exit. The imperfectly dried leaf is then transferred to a 72-inch drying machine of similar construction, where it is subjected on successive trays to a current of air heated to 190° F. until perfectly dry and brittle. Experience with

this system of firing has demonstrated a satisfactory development of the desired cup qualities and style in the dry tea.

GREEN TEA.

In making green tea the oxidative fermentation process, through which the characteristic color and flavor of black tea are produced, must be inhibited as completely as possible. This reaction requires three things: An oxidizing enzyme or ferment, the oxygen of the air, and a substance upon which the oxygen acting under the influence of the enzyme reacts. Whenever a tea leaf is crushed or the cells broken in any other way and then exposed to the air, a browning of the leaf takes place, due to the occurrence of this reaction in the injured tissues, and the enzymes and other substances react in the presence of the air to produce dark-colored substances. In making black tea this oxidizing reaction is facilitated. It has been ascertained by technical laboratory studies that this reaction may be conveniently suppressed by destroying the enzyme, heat being the most available agent for doing this.

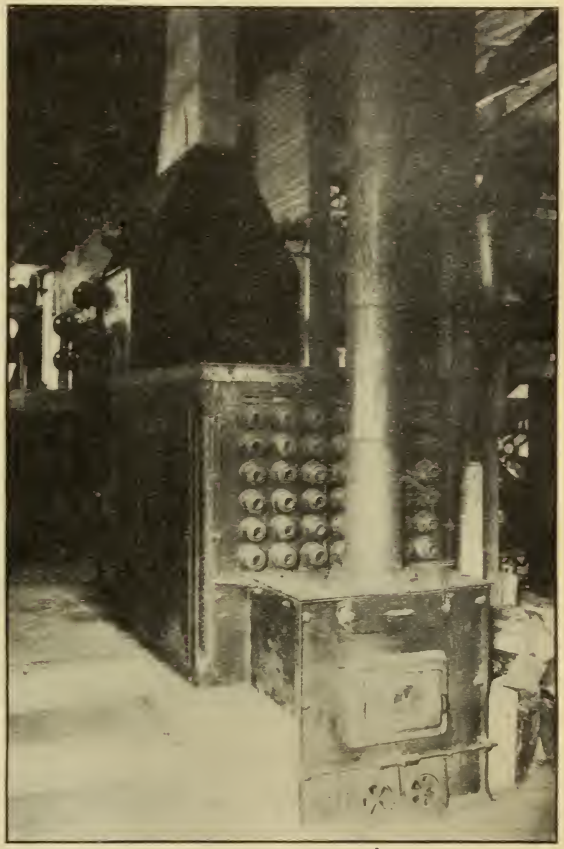


FIG. 7.—Furnace end of drying machine.

When green tea is made, the first step taken after the leaves are plucked aims to destroy the oxidizing enzymes and prevent the reaction referred to. Various methods of accomplishing this purpose are in use in many parts of the tea-producing area. Heating in pans or baskets is practiced in China and Japan, while the same object is

sought in India and Ceylon by steaming the leaves in a closed space. In the former case only small quantities of tea can be prepared at a time, since the process requires much labor and manual skill and the results are occasionally imperfect. In the steaming process the cooking of the leaf frequently causes a loss of aromatic and other valuable constituents.

A machine (fig. 8) has been designed by Dr. Shepard to do the sterilizing, and very favorable results are obtained with it. This machine consists of a horizontal rotary cylinder about 12 feet long with spiral flights on the inside that cause the leaves to fall several hundred times through its full diameter (20 inches) during their passage through the cylinder. At 14 revolutions to the minute it takes

FIG. 8.—Loading end of sterilizer.

about seven minutes for the leaf to pass from the feeding doors, where it encounters a current of air heated to from 550° to 600° F. drawn through the cylinder by a fan, to the discharging end where the temperature of the air does not exceed 212° F. The leaf is here delivered in a flaccid condition suitable for rolling and free from the active oxidizing enzymes. After rolling and "ball-breaking" it is ready for the firing machine. It is first fired at 230° F. until the excess of moisture is driven off and the roll feels gummy. Then it is rolled for 20 or 30 minutes under pressure, where it takes on a very tight twist. The firing is then completed at 190° F.

Although it is agreed by all writers on tea that the leaf for making green tea should be immediately manufactured, the present writer

has obtained excellent results by carrying over the leaf picked in the afternoon until the next morning before passing it through the machine. To accomplish this the leaf is spread about 6 inches deep in a cool room and the edges swept around so that no stray leaves may become withered. Leaf picked in the evening and carried over successfully appears to give a greener product than that picked and manufactured the same morning.

"SHELTER" TEA.

An interesting experiment has been made at Pinehurst in raising tea under shelter sufficient to protect the plants from the direct sunlight. It is also done in Japan, where the finished product is styled "sugar" tea and is highly appreciated, commanding an extra high price. The content of thein is very large and that of tannin quite small as compared with other teas. The leaves attain a very large size, are quite silky, and assume a decided blue color. The cup qualities are excellent, being delicate in flavor, free from astringency, and fairly fragrant.

At Pinehurst a garden of two-thirds of an acre has been covered with a frame, elevated so that the mules may plow under it, and spread with a rather open wire mesh on which the screen is placed. At first a covering of matting was used, which was rolled up at nightfall and spread in the morning during the development of a flush, but kept rolled up for a few days after the tea had been gathered. This proecdure was too expensive in labor and now pine straw spread over the woven wire is kept in place during the whole of the cropping season. Nevertheless, in view of the small yield, the cost of production is high, although the finished tea readily brings $5 a pound.

FINISHING PROCESSES.

Equalizing and sorting.—When tea comes from the firing machine the rolled leaves exhibit the same differences in length as when fresh from the gardens. In India and Ceylon the tea is "equalized," that is, passed through a machine which cuts the leaves to a product of fixed maximum size, after which the tea is sorted for the market by a series of sieves. The dust is taken out by the first sieve and the grades are separated in order of fineness, as follows: "Broken orange pekoe," "broken pekoe," "pekoe souchong," "souchong," etc. The method of sorting and grading the leaf at Pinehurst is essentially different from that generally practiced in India and Ceylon in that the cut leaf is not put with the highest grade, which has passed through the sieve without being cut. Thus the dried leaf is screened without a preliminary cutting and yields "fines," to which no part of that which could not pass through the screen is added. The second

quality is the product resulting from cutting and screening that portion which after cutting passes through the screen which separates the "fines." The third portion embraces all that could not pass through at the second screening. It is passed through the cutter until all the tea has been reduced to the requisite size. In other words, the cutting of an inferior large leaf does not entitle it to enter the the market as the equal of the originally smaller and superior leaf.

Attritionizing.—The very fine green teas of China and Japan receive their natural greenish color by rubbing in a warm pan for about an hour after the completion of the ordinary firing, but this

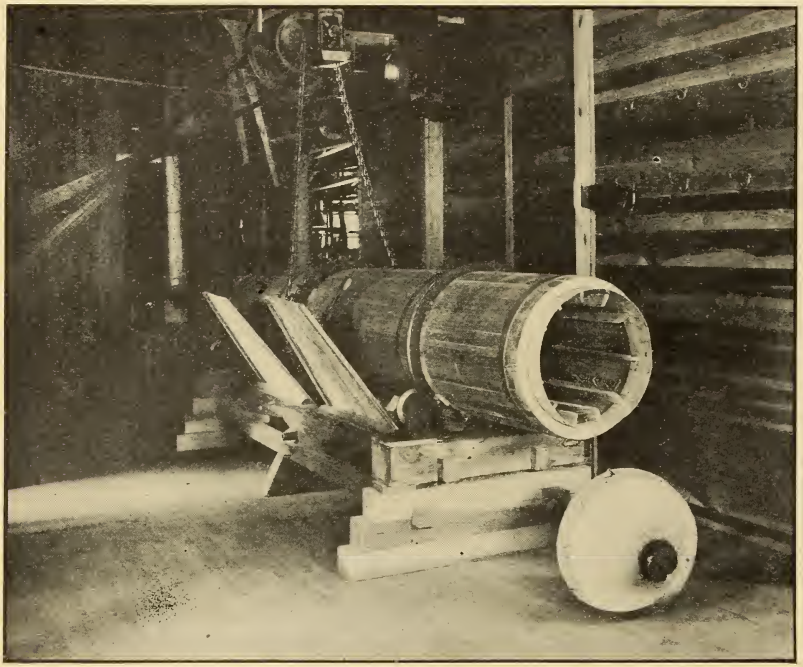


FIG. 9.—Attritionizer.

greenish tint of the "natural colored" tea did not satisfy the demands of the American market. To meet the desire for a more highly colored green tea, materials have been very generally added to oriental tea just before the completion of the firing in the form of a mixture of indigo or Prussian blue, turmeric, and soapstone, although usually in too small quantities to prove deleterious to health.

At Pinehurst the green teas are polished or colored without the addition of extraneous substances. It was observed that when dry tea was persistently stirred the friction of the tea leaves on each other developed the desired finish. A machine, called the attritionizer (fig. 9), was developed by Dr. Shepard in which this principle

was so worked out as to permit the finishing of tea on a large scale. It consists essentially of a revolving horizontal cylinder in which the tea is kept in motion in a current of air previously heated to a point not to exceed 180° F. This process requires from two to three hours and owing to the slight demand on the power is performed with but little cost.

Culling.—With the strictest superintendence small pieces of twigs and undesirable leaves will escape the notice of the inspectors. After the tea is otherwise finished these pieces are easily noticeable and the larger pieces have to be culled out by hand. This culling is generally done by girls and costs from a half cent to 1 cent a pound.

Dusting.—The last stage in the finishing process is that of dusting. During this operation the fine dust is blown out and the "broken" or "ragged" tea is separated from the rolled leaf. This operation improves the "style" of the product more than any other process, because the discolored pieces generally consist of coarse particles and leaves too tough to take on a roll, and they subsequently get broken into small, flaky pieces.

STORAGE.

The bins should be located in a separate room in the factory near the furnaces, so that the air in this room will be as nearly dry as possible. The rooms should be two stories high and the bins located on the sides against the walls, with a passageway between the rows. They should extend from the upper story, where the tea is put in, to within about 3 feet of the floor of the lower story. The bottom of the bins should slant and be provided with sliding doors for discharging the tea. The bins should be either zinc lined or made of two thicknesses of well-seasoned boards, with odorless building paper between them. The inside lining of boards should be tongued and grooved and should extend up and down, so that the tea may not lodge in the cracks. The bins should be of various sizes to prevent space being lost by differences in bulk. They should be kept locked by the manager or some competent person, to prevent any chance of mixing the different grades. Before being placed in the bins, each day's output should be tested and approved, as otherwise a small quantity of inferior tea might ruin a whole bin.

CONCLUSIONS DEDUCED FROM EXPERIENCE WITH TEA CULTURE AT PINEHURST.

The quantity of tea produced varies and is influenced by the seed, soil, climate, cultivation, pruning, plucking, and many other causes; but one fact must be borne in mind and that is that, no matter to what it is due, a large production seems to be made always at the expense of the quality of the product. This is not only the experi-

ence abroad, but is also true at Pinehurst. A slow development of leaf generally goes with a choice tea of high flavor.

Since the experiment was begun with the intention of acquiring information as to the possibility of producing commercial tea profitably in this country, it was necessary to extend the experimentation over as great a variety of soils and with as many kinds of seed as possible. The variation in the soils at Pinehurst made it an excellent place for obtaining this information. In procuring the many varieties of imported seed, aid was given by the Chinese and Japanese Governments by furnishing exceptionally valuable seed. Other consignments of seed were procured by the United States consuls and by purchase and gifts from many other sources. The plan of thoroughly testing the varieties of seed and their adaptability to different soils has been continued up to the present time, and, although many failures have been met and large expenditures incurred, much has been learned relative to the methods of seed and soil selection, cultivation, and manufacture that will be of material value to those who may embark in the business hereafter. Owing to the tentative nature of the work at Pinehurst, much money was spent in experimentation that can not justly be included in the expense of producing the commercial article.

As in India, Ceylon, and Java, large areas must be planted in this country in order to insure a profitable investment in tea culture, the relative cost of production decreasing as the acreage increases. Using the methods of selection, cultivation, and curing which have been developed at Pinehurst, it seems possible to estimate the profits that may properly be anticipated from a plantation of 200 acres or more. It should be borne in mind that economy of production demands the employment of special and generally expensive machinery, that its successful use requires the attention of skilled labor, and that when both are kept busy the cost of the output per pound will be cheaper. Again, the systematic superintendence of the gardens and factory and the general management of the business require intelligence and constant application. Under these circumstances, the establishment and maintenance of a commercial tea estate assume the proportions and pecuniary necessities comparable to those of a cane-sugar or beet-sugar project.

Before any outlay is incurred, and after a thorough investigation, a careful decision should be reached as to the character of the output of the tea and the means of disposing of it, as future success will largely depend on the correctness of the judgment in these matters.

Equally important is the selection of a suitable location. The requirements for the latter are fertile, cleared, well-drained, and rather level land and abundant cheap laborers, especially women and children. The location should be healthful, admitting of the

residence of the manager on the estate during the summer season, and transportation should be cheap, with easy access to the contemplated market. Especial care should be exercised that the gardens be established on a rich, deep, loamy soil, so that no necessity shall arise for the application of expensive enrichments, especially commercial fertilizers, which in themselves are liable to consume what otherwise might be a profitable return on the undertaking.

It is to be remembered that a tea garden with a production of less than 250 pounds to the acre can hardly prove remunerative, and that perhaps seven years may elapse from the planting of the seed until this rate of yield is obtained. On the other hand, the proper installation is for a very long term of years. According to presumably accurate information there are in the Orient some gardens in which the original bushes have continued to produce excellent tea for several hundred years, and it is beyond all doubt that in India and Ceylon there are gardens which have steadily yielded profitable crops for 25 years and perhaps longer.

COST AND PROFIT OF TEA PRODUCTION.

Bearing in mind the lessons coming from the Pinehurst experiment, the writer has prepared an analytical estimate covering the financial prospects of the would-be tea grower establishing himself in the Southern States. A working capital of at least $50,000 must be available for the purchase of adequate real estate and equipment and to meet other necessary expenses to be incurred before the income from the operation becomes sufficient to bear them. The area to be used for tea growing should not be less than 200 acres. When the tea estate contains less than this area it is presumed that the proprietor will manage it with the help of a qualified foreman. In this estimate no charge is made for superintendence. The remuneration of a first-class tea superintendent would absorb too large a proportion of the gross profits unless the estate covered more than 200 acres. When one reflects on the difficulty of disposing of a new variety of merchandise, the necessity for considerable expenditure in advertising or its equivalent is very evident—another reason for enlarging the crop area so that the cost of distribution may be diminished.

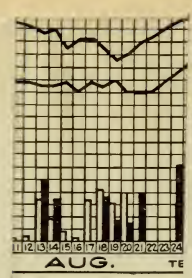
Table IV, based on the data secured at Pinehurst, has been prepared to show the estimated expenditures for the purchase of land, erection of factory and farm buildings, cost and maintenance of mules, and the various field and factory operations. It does not include the cost of management, taxes, fire insurance, or possible outlays for advertisements, and presupposes the selection of sufficiently fertile lands to obviate, at least for many years, the purchase of any commercial fertilizers.

TABLE IV.—*Estimated expenditure and income of the first 10 years on a tea plantation of 200 acres.*

Items.	First year.	Second year.	Third year.	Fourth year.	Fifth year.	Sixth year.	Seventh year.	Eighth year.	Ninth year.	Tenth year.
Unreturned expenditures brought forward	.....	$20,000	$25,650	$36,195	$39,079	$39,415	$36,524	$28,781	$18,146	$6,766
Interest at 7 per cent	.....	1,400	1,795	2,534	2,736	2,759	2,557	2,015	1,270	474
Purchase of land and erection of buildings	[1] $15,000	.....	[2] 5,000	.....	.....	2,000	.....	.....	.....	.....
Plowing[3] and hoeing	.....	500	1,500	1,500	1,250	1,000	800	800	800	800
Purchase and upkeep[4] of mules	2,500	500	[5] 2,000	500	500	500	500	500	500	500
Supplies and incidentals	1,000	250	250	250	250	250	250	250	250	250
Nurseries and transplanting (American seed)	1,500	3,000	.....	.....	.....	.....	.....	.....	.....	.....
Pruning	.....	.....	.....	[6] 300	[6] 300	[7] 400	[7] 400	[8] 500	[8] 500	[9] 600
Plucking leaf	.....	.....	.....	[10] 400	[11] 700	[12] 1,400	[13] 1,750	[14] 2,100	[14] 2,100	[14] 2,100
Factory	.....	.....	.....	[15] 400	[16] 600	[17] 800	[17] 1,000	[17] 1,200	[17] 1,200	[17] 1,200
Total outlay	20,000	25,650	36,195	42,079	45,415	48,524	43,781	36,146	24,766	12,690
Sales of tea at 30 cents a pound	.....	.....	.....	3,000	6,000	12,000	15,000	18,000	18,000	18,000
Indebtedness	20,000	25,650	36,195	39,079	39,415	36,524	28,781	18,146	6,766	.....
Profit after liquidation of investment	.....	.....	.....	.....	.....	.....	.....	.....	.....	5,310

[1] Land, $10,000; farm buildings, $2,500; cleaning up, ditching, etc., $2,500.
[2] Erection of factory, $5,000.
[3] The expense for plowing includes the feed for mules while so engaged. It is calculated that enough extra land will be included in the purchase of the plantation to provide ample feed for the mules.
[4] The item of upkeep for mules is meant to cover wages of plowmen when employed in other than tea cultivation. The increase in mules is not accompanied with additional expense in upkeep, as the land devoted thereto should afford larger returns under continued cultivation.
[5] Purchase of additional mules, $1,500.
[6] Pruning, at $1.50 per acre.
[7] Pruning, at $2 per acre.
[8] Pruning, at $2.50 per acre.
[9] Pruning, at $3 per acre.
[10] Plucking 50 pounds dry tea per acre, at 4 cents per pound.
[11] Plucking 100 pounds dry tea per acre, at 3½ cents per pound.
[12] Plucking 200 pounds dry tea per acre, at 3½ cents per pound.
[13] Plucking 250 pounds dry tea per acre, at 3½ cents per pound.
[14] Plucking 300 pounds dry tea per acre, at 3½ cents per pound.
[15] Factory work, at 4 cents per pound.
[16] Factory work, at 3 cents per pound.
[17] Factory work, at 2 cents per pound.

It will be observed that the annual production, gradually rising to 300 pounds of dry tea per acre, valued at an average selling price of 30 cents a pound, suffices in 10 years from the starting of the enterprise to liquidate the entire investment (with certain exceptions), but when it is remembered that some of the Pinehurst tea gardens have produced at a much greater rate, the estimate of 300 pounds may be regarded as quite conservative. If, in and after the sixth year, instead of using the total proceeds from the sale of tea for extinguishing the indebtedness of the estate, $6,000 be taken yearly as a dividend, the entire investment may be cleared in 16 years. With the obligations paid, the plantation should bring in an annual income of at least $10,000 for an indefinite period. If the gardens embrace 400 acres, the cost per pound of finished tea should be materially lessened and the total profit of the estate much more than doubled.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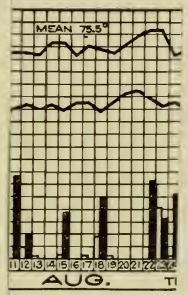
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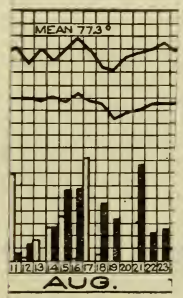
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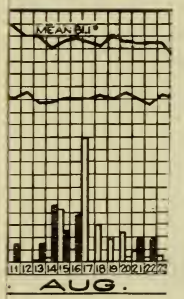
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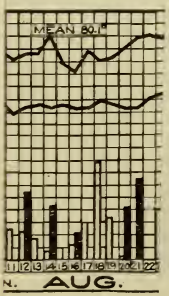

MEAN 80.1°
AUG.

1901
MEAN TEMPERATURE 57.5°
DAILY MAXIMUM TEMPERATURE
DAILY MINIMUM TEMPERATURE
INCHES RAINFALL
POUNDS OF TEA
MEAN 71.2°
MEAN 75.8°
MEAN 70.9°
MEAN 77.6°
MEAN 74.1°
MEAN TO 31ST 63.4
RAINFALL 4.50 IN. APRIL TEA 0 LBS.
RAINFALL 4.83 IN. MAY TEA 872 LBS.
RAINFALL 7.64 IN. JUNE TEA 408 LBS.
RAINFALL 5.15 IN. JULY TEA 620 LBS.
RAINFALL 7.78 IN. AUG. TEA 645 LBS.
RAINFALL 0.81 SEPT. TEA 804 LBS.
RAINFALL TO 31ST 0.83 OCT. TEA 121 LBS.
TOTAL RAINFALL 31.00 IN.
TOTAL POUNDS OF TEA 3,393
1902
MEAN TEMPERATURE 62.2°
MEAN 73.4°
MEAN 75.6°
MEAN 76.3°
MEAN 77.2°
MEAN 65.0
RAINFALL 1.15 IN. APRIL TEA 5 LBS.
RAINFALL 3.25 IN. MAY TEA 1281 LBS.
RAINFALL 2.71 IN. JUNE TEA 860 LBS.
RAINFALL 5.40 IN. JULY TEA 1343 LBS.
RAINFALL 6.32 IN. AUG. TEA 1636 LBS.
RAINFALL 5.66 IN. SEPT. TEA 721 LBS.
RAINFALL TO 31ST 5.13 IN. OCT. TEA 121 LBS.
TOTAL RAINFALL 30.36 IN.
TOTAL POUNDS OF TEA 6,103
1903
MEAN TEMPERATURE 59.7°
MEAN 66.8°
MEAN 74.6°
MEAN 82.2°
MEAN 78.4°
MEAN 71.5°
MEAN TO 31ST 69.1°
RAINFALL 2.65 IN. APRIL TEA 126 LBS.
RAINFALL 5.75 IN. MAY TEA 1348 LBS.
RAINFALL 7.37 IN. JUNE TEA 1183 LBS.
RAINFALL 3.13 IN. JULY TEA 1217 LBS.
RAINFALL 7.63 IN. AUG. TEA 1118 LBS.
RAINFALL 4.75 IN. SEPT. TEA 834 LBS.
RAINFALL TO 31ST 0.39 IN. OCT. TEA 75 LBS.
TOTAL RAINFALL 37.18 IN.
TOTAL POUNDS OF TEA 5,955
1904
MEAN TEMPERATURE 58.3°
MEAN 64.6°
MEAN 71.5°
MEAN 77.3°
MEAN 78.9°
MEAN 72.1°
MEAN TO 22ND 69.1°
RAINFALL 0.87 IN. APRIL TEA 61 LBS.
RAINFALL 2.77 IN. MAY TEA 1258 LBS.
RAINFALL 2.37 IN. JUNE TEA 656 LBS.
RAINFALL 8.44 IN. JULY TEA 1071 LBS.
RAINFALL 8.68 IN. AUG. TEA 1044 LBS.
RAINFALL 2.81 IN. SEPT. TEA 806 LBS.
RAINFALL TO 22ND 1.27 IN. OCT. TEA 154 LBS.
TOTAL RAINFALL 27.81 IN.
TOTAL POUNDS OF TEA 5,009
1905
MEAN TEMPERATURE
MEAN 77.5°
MEAN 79.8°
MEAN 77.3°
MEAN 78.5°
MEAN TO 21ST 69.°
RAINFALL 3.85 IN. APRIL TEA 0 LBS.
RAINFALL 4.05 IN. MAY TEA 1437 LBS.
RAINFALL 2.12 IN. JUNE TEA 671 LBS.
RAINFALL 6.84 IN. JULY TEA 1220 LBS.
RAINFALL 7.61 IN. AUG. TEA 1537 LBS.
RAINFALL 3.66 IN. SEPT. TEA 804 LBS.
RAINFALL TO 21ST 0.72 IN. OCT. TEA 40 LBS.
TOTAL RAINFALL 32.85 IN.
TOTAL POUNDS OF TEA 6,569
1906
MEAN TEMPERATURE 56.3°
MEAN 71.4°
MEAN 79.6°
MEAN 81.°
MEAN 78.1°
MEAN TO 19TH 74.1°
RAINFALL 1.55 IN. APRIL TEA 0 LBS.
RAINFALL 2.37 IN. MAY TEA 2386 LBS.
RAINFALL 6.86 IN. JUNE TEA 1358 LBS.
RAINFALL 3.27 IN. JULY TEA 2010 LBS.
RAINFALL 6.26 IN. AUG. TEA 1685 LBS.
RAINFALL 4.78 IN. SEPT. TEA 837 LBS.
RAINFALL TO 19TH 1.24 IN. OCT. TEA 54 LBS.
TOTAL RAINFALL 26.83 IN.
TOTAL POUNDS OF TEA 8,627
1907
MEAN TEMPERATURE 58.2°
MEAN 71.3°
MEAN 76.6°
MEAN 81.8°
MEAN 80.°
MEAN 76.6°
MEAN TO 31ST 72.0°
RAINFALL 5.38 IN. APRIL TEA 0 LBS.
RAINFALL 2.85 IN. MAY TEA 1232 LBS.
RAINFALL 3.20 IN. JUNE TEA 621 LBS.
RAINFALL 5.35 IN. JULY TEA 1334 IN.
RAINFALL 7.35 IN. AUG. TEA 1853
RAINFALL 3.39 IN. SEPT. TEA 617 LBS.
RAINFALL TO 31ST 0 OCT. TEA 15 LBS.
TOTAL RAINFALL 31.69 IN.
TOTAL POUNDS OF TEA 6,645

AUG.
MEAN 77.4°
AUG.
MEAN 76.3°

It is apparent from the experience of tea planters in other parts of the world that the most influential factors with which one has to deal, apart from soil characters, are the rainfall and prevailing temperatures. It was recognized that carefully kept records of these conditions when correlated with the tea yield would be certain to give results of the utmost practical importance. Accordingly, such records were kept, and the results of the observations of seven years are presented graphically in the accompanying chart, figure 10. This chart shows the relation of temperature and rainfall to the production of tea in twelve of the gardens at Pinehurst during this 7-year period. The computations are given for each day. The upper irregular lines show the maximum temperature; the lower irregular lines, the minimum temperature; the closed columns, the production of dry tea in pounds; and the open columns, the rainfall in inches.

Table V describes these twelve gardens and the yield of tea. Since the gardens were situated on widely varying soil types, the record of each was kept separately, thus providing a test of these different types of soil conditions. It is clear that during this extended period the gardens have had time to pass through various stages of maturity, a fact which influences somewhat the interpretation of the results. As the gardens here enumerated form but a portion of the tea area of Pinehurst, it must be borne in mind that the totals given do not indicate the entire output of Pinehurst at any time.

TABLE V.—*Description of tea gardens included in the study of tea production in relation to temperature and rainfall.*

Names of gardens.[1]	Variety of tea plant.	Character of soil.	Area.	Date of first plucking.	Production of dry tea.							Fertilizer[2] (200-pound sacks).						
					1901	1902	1903	1904	1905	1906	1907	1901	1902	1903	1904	1905	1906	1907
			Acres.	*Year.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*							
Old Rose	Assam hybrid	Rich sandy loam; a subsoil-drained piny-woods pond.[3]	0.89	1892	309	392	375	323	429	342	277	4	4	4	5	6½	5	3½
North Bottom	do	Fertile sandy loam; quite sloping	2.66	1892	243	435	268	366	505	481	402	6	8	7	6	6	6	6
South Bottom	do	Part loamy bottom; part clayey upland.	3.78	1893	278	388	437	412	338	422	335	5	5	6	8	6	6	5½
Field's Hedges	do	Part quite sandy; part drained rich piny-woods pond.[3]	4.11	1898	246	652	597	367	557	724	485	10½	12	6	5¾	7	6⅔	6
Indo-Ceylon	do	Thin sandy loam on clay	7.29	1896	428	787	908	686	671	799	395	10½	12	13¾	16½	24⅓	12	10
North Fraser	do	Very sandy and poor soil	2.50	1898	163	309	322	217	304	275	181	6	8	7	7¼	6	6	4
South Fraser	Dragon's Pool Chinese.	Rather sandy loam on good clay subsoil.	2.00	1894	186	504	410	281	339	690	475	7	8	7	9⅓	9	8½	6
Young Chinese No. 2.	do	Part sandy loam on hillsides; part rich bottom.	3.67	1899	172	406	521	406	437	708	568	0	0	6	6¼	8	8⅓	8
Lincoln Pond	Darjeeling	Rich piny-woods pond; well drained[3]	1.90	1896	347	554	502	504	620	660	639	4	4	4	5	5	5	5
North Fortune	do	Quite sandy and thin soil; high elevation and dry.	8.15	1898	508	866	824	834	1,008	1,052	574	11	12	15	15½	23	16	15
South Fortune	do	Drained piny-woods pond; rich in center, poor on edges.[3]	3.00	1898	289	446	448	432	594	669	566	3	4	4⅓	5	5	5	5
King Lot	Mixed	Sandy, much interspersed with trees.	6.63	1894	198	369	339	269	282	418	181	10	10	13	14	10½	10½	3

[1] In selecting the gardens for comparison it was sought to present an average of the conditions here prevalent, i. e., both good and poor soil, as also low, moist locations and high, dry locations. Attention is especially called to the exceptionally large production of tea in 1902 and 1906, when abundant rainfall and high temperatures prevailed during the cropping season. These conditions and rather severe pruning influenced the quantity of yield more than an increase in the fertilizer applied, although the table exhibits a few instances due to the last cause, viz, Old Rose in 1905, South Bottom in 1903, and North Fortune in 1905.

[2] The fertilizer contains 4 per cent each of available phosphoric acid and potash, K_2O, and yields same amount of ammonia (from dried fish and dried blood).

[3] See description on following pages.

CONDITIONS IN THE GARDENS.

Since the gardens under study represent widely varying conditions, it is necessary in order to enable the reader to properly interpret the results to give a brief discussion of each garden.

Old Rose Garden.—The site of this garden was formerly a piny-woods pond. The soil is a rich, sandy loam, thoroughly subsoil drained. This Assam-hybrid garden has yielded at the rate of over 400 pounds of dry tea to the acre during the past eight years. Previous to the spring of 1899, when the thermometer fell to $-\frac{1}{2}^\circ$ F., the plants had developed into comparatively small clumps, but in consequence of that freeze it became necessary to cut them off to the ground, by reason of which, and an equally severe pruning in the spring of 1907, the clumps each consisted of 50 or more vigorous shoots and in each instance showed a notable increase of production the second year thereafter. Cowpeas have been regularly planted in the rows and plowed in when grown. The garden is 16 years old and most vigorous.

North Bottom, or Swamp, Garden.—This garden lies on land sloping 2 to 3 feet to the hundred from the first sandy plateau to the swamp level; consequently, rains and water from the lands in the rear washed off a great deal of the topsoil, depositing it in the ditch and swamp at its lowest level and leaving many of the tea plants on cones of the topsoil held in place by the roots of the bushes. The soil was restored to a considerable extent and is now held in place by a series of embankments, which are gradually forming terraces in the garden. The first effect of the replacement of the soil was to deprive the roots of a large part of the benefit of the dews and light showers, but owing to the spreading of the rootlets upward an improvement is noticeable. The yield of the bushes, which are generally large and thrifty, was not satisfactory, however, and they were pruned severely in the spring of 1909 in the expectation that the production would be notably increased. The soil is a light sandy loam.

South Bottom, or Swamp, Garden.—This garden consists partly of low, flat, rather rich sandy-loam soil and partly of thin, sandy topsoil overlying clay on a hillside which required terracing. Pecan trees are on both soils and the Pinehurst experience opposes such contiguity. The garden has not produced the quantity of tea expected. The lower portion has been liberally treated with complete fertilizers and barnyard manure applied in trenches between the tea rows. It is possible that the subsoil was not sufficiently drained and that the pecan trees operated disadvantageously, but the falling off in production was more probably due to the lack of severe pruning for several seasons. It was heavily pruned back and the soil freely enriched during the spring of 1909. The bushes are now in good form and show very few breaks in the rows.

Field's Hedges Garden.—Field's Hedges Garden consists partly of a drained lowland, formerly a piny-woods pond, with very rich alluvial soil in which the tea hedges exhibit great luxuriance and each autumn almost cover the entire surface. The rest of the soil is sandy upland, which at the beginning of cultivation was almost sterile. Free enrichment with barnyard and commercial manures, the cultivation of cowpeas between the rows, and severe pruning (notably in 1904) have done much to improve the soil and the crops.

Indo-Ceylon Garden.—This garden lies mostly on high, sandy land with pecan trees through the greater part of it. It was planted with seedlings from Assamese and Ceylonese seed, but they were not hardy enough to withstand the climate and were replaced with the tea that resembles the eastern Assam-hybrid and that is virtually hardy by reason of long cultivation in this country. The poverty of the soil and the presence of the pecan grove have so reduced the production that it has been determined to destroy the tea bushes and subject the land to a thorough treatment by green manuring. Seed obtained from greater elevations than 5,000 feet in Ceylon is capable of attaining excellent growth in this climate, as large gardens of the same in other locations at Pinehurst abundantly demonstrate.

North Fraser Garden.—This garden, too, has demonstrated the uselessness of attempting to raise tea profitably on high and sandy lands. The cost of applying sufficient enrichment to produce fairly remunerative crops for a few years proves later inadequate, as the stock of humus in the soil is depleted, despite even the introduction of legumes between the rows and frequent severe pruning. Under these circumstances it is well to abandon the cultivation of tea on such worn-out land (as is often done in the Orient) or, better, to restrict the establishment of tea gardens to rich lands whose fertility may extend over many years.

South Fraser Garden.—The South Fraser Garden lies mostly on a slightly elevated hill and has a sandy loam resting on a rather rich, clayey subsoil. The bushes were grown from seed furnished by the Chinese Government from the celebrated Dragon's Pool tea estate. They are dwarfish, but although planted 4 feet apart almost cover the ground. The leaf is generally small, but affords most delicate green tea and yields to the extent of over 300 pounds to the acre in favorable seasons when the temperature is high. The garden has been freely enriched with both stable and commercial manures, but an occasional severe pruning is indispensable for the maintenance of thrifty growth.

Young Chinese No. 2.—This garden occupies the bottom and sides of a rather shallow ravine. The former has a rich, deep, loamy soil; the latter is somewhat sandy, underlain by a rich clay subsoil. The plants come from the Dragon's Pool stock and in the bottom attain a

large size, perhaps because of the greater humidity of the soil. By more abundant fertilization and more severe pruning a larger yield may be expected without impairing the quality of the tea. The greater heat and abundant rainfall of 1906 materially increased the output. The bushes are larger than those from the original imported seed, perhaps in part the result of hybridization, but the tea made therefrom does not exhibit any deterioration.

Lincoln Pond Garden.—This was the site of a piny-woods pond. It was thoroughly subsoil drained and planted with seedlings raised from seeds that came from the Pashok tea estate in Darjeeling on the slopes of the Himalaya Mountains in British India. This variety of leaf can be made into either a black or a green tea quite rich in flavor, yet delicate. On the rich soil of the old pond and without much enrichment it readily yields at the rate of over 300 pounds of dry tea to the acre.

North Fortune Garden.—North Fortune Garden is on a high, dry, and sandy hill. As the thin surface soil became exhausted, the annual crop of tea diminished to such an extent that it appeared wise to discontinue its use for a tea garden; but increasing its fertility by summer and winter legumes, stimulated by acid phosphate and kainit, has given excellent results at Pinehurst. Had this garden been nearer to the cattle barns, an attempt to enrich it with farm manure would have been made.

South Fortune Garden.—This garden is situated where once lay a piny-woods pond, the center having a deep, rich loam, but the soil on the surrounding slopes is decidedly sandy. The pond proper is subsoil drained. In 1903 after an unusually heavy rainfall the main drain became clogged and before the water could be removed from the roots a considerable number of the best tea bushes in the center of the garden perished. Wherever subsoil drainage is maintained by open-joint tile pipes it is absolutely necessary to keep the overlying earth free from thirsty tree and shrub roots; otherwise they will clog the pipes and in two or three weeks can kill the tea plants if the subsoil water is stagnant that long.

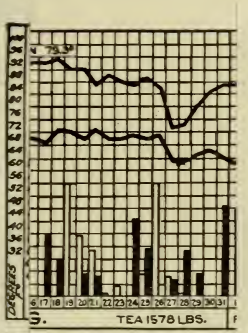
King Lot Garden.—This garden occupies the intervening spaces in groves of yellow pines and pecans. The soil is sandy and unpromising for the profitable production of tea. Nevertheless, it was planted with tea bushes partly as an ornament to the Pinehurst park and partly to prevent the growing up of unsightly or detrimental bushes. It is probable that the output of tea covers the cost of keeping the ground clear of the undesirable bushes. This garden was included in the list of those shown on the chart, as it was designed to present an average of many conditions and results in gardens which were in bearing previous to 1901.

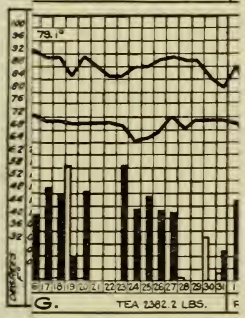
CONCLUSIONS DEDUCED FROM A STUDY OF THE GARDENS.

As a result of the experiments with the 12 gardens at Pinehurst, one of which was established without reference to possible remunerative yield, 3 have proved that the successful production of commercial tea upon a sandy soil devoid of humus is practically impossible. Half of the remainder have averaged 250 pounds of dry tea to the acre during the last four years of the period, and the others are not far behind them. This lesson has been duly appreciated and all subsequently installed gardens have been planted on richer and moister land. So fertile have been some of them that there appeared no necessity for applying enrichment to them, as has been demonstrated by the following returns from comparatively young and unmanured gardens, namely, Formosa, 412 pounds of dry tea per acre; Chinese, 314 pounds; Darjeeling, 315 pounds; Assam-hybrid, 284 pounds; and Kangra, 253 pounds. With a yield of 250 pounds of dry tea to the acre, the cultivation of tea at Pinehurst becomes remunerative although burdened in some instances by an expenditure of $6 per acre for commercial fertilizers. At 400 pounds to the acre it can not fail to be quite profitable.

In addition to the records showing the performance of selected gardens, the records of rainfall, temperature, and total tea yield for the entire estate have been prepared for the period of three years from 1908 to 1910, inclusive. These relations are shown in the accompanying chart, figure 11. The records cover each day. The upper irregular lines show the maximum temperature; the lower irregular lines, the minimum temperature; the closed columns, the production of dry tea in pounds; and the open columns, the rainfall in inches. It will be noticed that the temperatures for 1908 were very low, especially in May, which is probably the cause of the very poor crop for that year. In 1909 a fairly large crop was produced, due to rather high temperatures and a very regular distribution of the rainfall during the plucking season. The diminished production in 1910 was caused mainly by a strike of the laborers during the pruning season, which interfered with the pruning of some of the gardens. The very low maximum temperature, the severe drought early in the spring, and the fact that the plucking extended only to September 8 combined to reduce materially the production of tea for the season of 1910. The quality of the tea for 1910 excelled that of any previous year on account of the slow development of the leaf and the early cessation of plucking.

Figure 11 is especially interesting, as it includes one year (1909) of fairly ideal weather conditions for tea growing. The other two years, 1908 and 1910, show how much the production might be reduced by either unfavorable weather or labor conditions.


78.9°
TEA 1578 LBS.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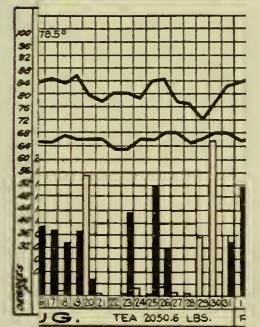
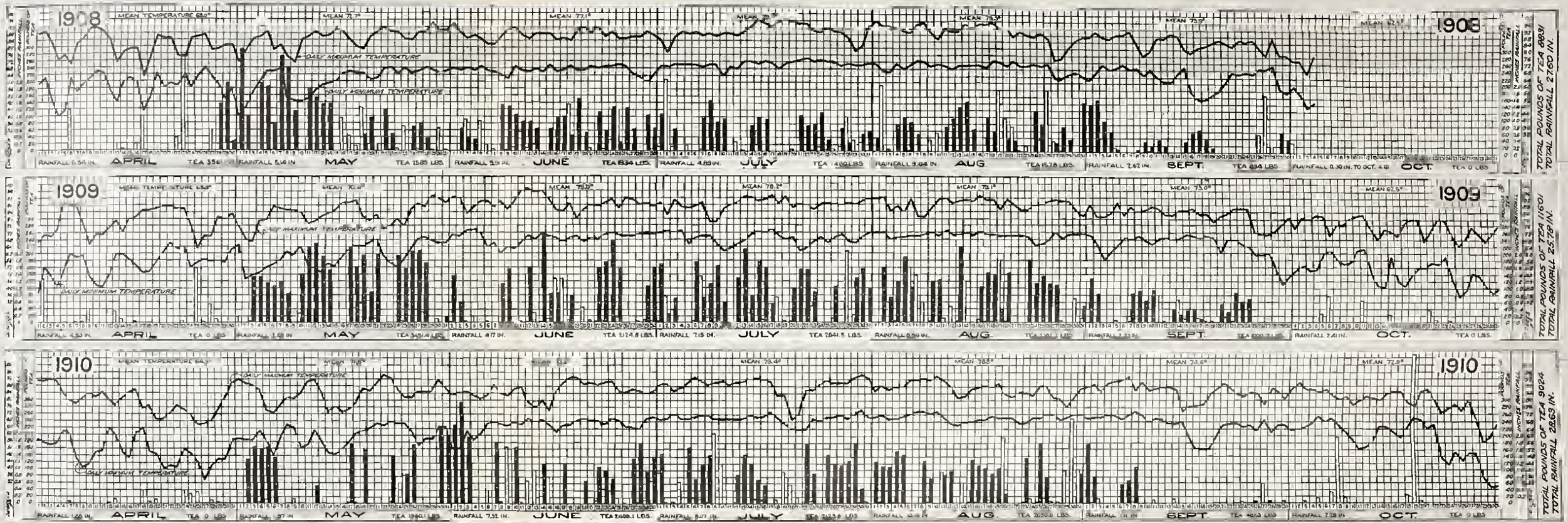
TEA 2382.2 LBS.


78.5°
TEA 2050.6 LBS.


1908
MEAN TEMPERATURE 69°
MEAN 71.7°
MEAN 77.1°
MEAN 78.2°
MEAN 78.9°
MEAN 75.9°
MEAN 67.5°
1908
DAILY MAXIMUM TEMPERATURE
DAILY MINIMUM TEMPERATURE
TOTAL POUNDS OF TEA 6891
TOTAL RAINFALL 27.60 IN.
RAINFALL 6.54 IN. APRIL TEA 356 LBS.
RAINFALL 5.14 IN. MAY TEA 1585 LBS.
RAINFALL 5.51 IN. JUNE TEA 1834 LBS.
RAINFALL 4.89 IN. JULY TEA 1801 LBS.
RAINFALL 3.04 IN. AUG. TEA 1578 LBS.
RAINFALL 2.62 IN. SEPT. TEA 634 LBS.
RAINFALL 0.30 IN. TO OCT. 4 IN. OCT. TEA 0 LBS.
1909
MEAN TEMPERATURE 65.5°
MEAN 70.4°
MEAN 75.0°
MEAN 78.2°
MEAN 73.1°
MEAN 73.0°
MEAN 67.5°
1909
DAILY MAXIMUM TEMPERATURE
DAILY MINIMUM TEMPERATURE
TOTAL POUNDS OF TEA 11601
TOTAL RAINFALL 25.76 IN.
RAINFALL 4.53 IN. APRIL TEA 0 LBS.
RAINFALL 2.68 IN. MAY TEA 345.4 LBS.
RAINFALL 4.17 IN. JUNE TEA 1124.8 LBS.
RAINFALL 7.15 IN. JULY TEA 2641.5 LBS.
RAINFALL 0.59 IN. AUG. TEA 2161.7 LBS.
RAINFALL 2.32 IN. SEPT. TEA 600.7 LBS.
RAINFALL 2.41 IN. OCT. TEA 0 LBS.
1910
MEAN TEMPERATURE 66.5°
MEAN 71.6°
MEAN 73.4°
MEAN 78.5°
MEAN 73.6°
MEAN 72.3°
1910
DAILY MAXIMUM TEMPERATURE
DAILY MINIMUM TEMPERATURE
TOTAL POUNDS OF TEA 9024
TOTAL RAINFALL 28.63 IN.
RAINFALL 1.88 IN. APRIL TEA 0 LBS.
RAINFALL .97 IN. MAY TEA 1960.1 LBS.
RAINFALL 7.51 IN. JUNE TEA 2468.1 LBS.
RAINFALL 5.27 IN. JULY TEA 2323.8 LBS.
RAINFALL 4.18 IN. AUG. TEA 2050.6 LBS.
RAINFALL 1.11 IN. SEPT. TEA 469.3 LBS.
RAINFALL 7.28 IN. OCT. TEA 0 LBS.